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Homemade Salvage Setup for a Catastrophic Heater/Cooler Failure on Cardiopulmonary Bypass

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Abstract: Perfusion-related problems are still reported at incidence, varying from .72 to 2.86%, and add to the morbidity and mortality of cardiac surgery. Awareness of such problems and establishing protocols to avoid and manage them is a key factor in further improving patient outcomes. In this report, we describe a homemade setup which was used as a desperate salvage measure to rewarm a 1-year-old baby on cardiopulmonary bypass for intracardiac repair, who was inadvertently cooled to 24°C because of a malfunctioning heater/cooler machine. **Keywords:** heater/cooler failure, cardiopulmonary bypass. *J Extra Corpor Technol. 2019;51:169–71*

OVERVIEW

Since its first successful use in 1953 (1), cardiopulmonary bypass (CPB) has undergone immense technical and technological modifications, making it possible to do increasingly complex cardiac surgeries on age groups ranging from neonates to nonagenarians with good results (1). However, perfusion-related incidents and equipment failure still occur at a frequency of up to 2.86%, resulting in the incidence of serious injury or death of .07 to .08% (2,3). Awareness among the surgical team of such problems and establishing protocols to avoid and manage them is key in the further improvement of patient outcomes (4,5).

This report explains how our team dealt with a difficult situation during a pediatric cardiac surgery in a remote area of India when a heater/cooler device malfunctioned and a patient was inadvertently cooled to 24°C. Although heater/cooler malfunctions have been previously reported (3,4), rewarming without a backup heater/cooler device and an innovative setup offers a new solution to rewarming a patient during CPB.

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DESCRIPTION

During a charity pediatric cardiac surgery camp at a remote town in India, a 1-year-old, 8-kg female patient presented for repair of a ventricular septal defect (VSD) complicated by a double-chambered right ventricle–type infundibular obstruction. Our normal protocol for this type of repair is to maintain patient temperature at 35°C throughout CPB. The equipment consisted of a Sarns 8000 (Terumo cardiovascular group, Ann Arbor, MI) CPB machine, a Maquet HCU 40 (Maquet-Getinge, Rassat, Germany) heater/cooler device, and Sorin D 901 (Sorin Liva Nova, London, UK) and Sorin CSE 14 cardioplegia delivery systems. We used a ¼-inch-sized uncoated venous, arterial and pump boot extracorporeal circuit (BL Life Sciences, New Delhi, India). The patient's nasopharyngeal temperature was monitored, and the usual practice was to maintain a gradient of not more than 8°C between the patient's nasopharyngeal temperature and heater cooler bath. Halfway during the intracardiac repair, the anesthesia and perfusion team noticed a software malfunction with the heater/cooler device, resulting in an inability to maintain patient temperature at 35°C. The device was rebooted several times without resolution of the malfunction.

Unfortunately, a replacement device was not immediately available and one could not be delivered for at least 2–3 hours. The surgeons were then informed about the problem, and by this time, the patient's temperature had drifted down to 26°C. By the time we finished the intracardiac repair, the core temperature had reached 24.3°C.

After repair of the VSD and resection of the muscle bundles, the cross clamp was removed. Now, the surgical team was faced with the perplexing choice of separating the baby from CPB without rewarming or maintaining the patient on CPB for four or more hours until a replacement heater/cooler device could be delivered and the patient could be rewarmed. As a team, we had never dealt with such a problem nor were we aware of any similar cases reported before, as most of the regular centres will have a backup machine available. Maintaining the baby for another 2–3 hours on CPB, while waiting for the backup machine, risked a very long and potentially hazardous bypass run for that child.

Options for rewarming without a heater/cooler were discussed, but each was associated with the potential for nonuniform warming of the myocardium, spinal cord, and kidneys. Finally, the perfusionist proposed setting up a steel tub of water with a temperature probe to act as a water bath. Warmed saline was added to the tub, which achieved a bath temperature of 28°C. One half inch tubing was inserted into the water bath and a spare pump head was used to pump warm water from the water bath into the heat exchanger water inlet. The water was drained from the heat exchanger back into the water bath (Figure 1). The water bath temperature was carefully maintained at 4–6° above the core temperature by adding small quantities of warm saline and immersing warm saline bottles into the water bath. Water bath temperatures did not exceed 37° at any time during rewarming. Cutaneous warming with a Bair Hugger device (3M, Maplewood, MN) was used to supplement the rewarming process. The patient was successfully rewarmed to 36°C in 70 minutes and safely separated from CPB.

We had a team meeting involving the hospital management on the next day, considering the seriousness of the incident. It was agreed that it would be safer to have a backup heater/cooler machine available and the management agreed to budget for a second machine. It was also agreed to ensure preventive maintenance of all CPB-related machinery as per the manufacturer's recommendation and to document it. This heater/cooler machine was serviced and repaired by Maquet service personal the next day.

Figure 1. Setup for rewarming without a heater/cooler machine. A: Temperature probe in water, B: Outlet pipe of heat exchanger, C: Inlet pipe of heat exchanger, D: Heat exchanger.

COMMENT

Heater/cooler failures and how to deal with these failures when a replacement device is not available have not been previously described. Rewarming a hypothermic patient and separation from CPB can be challenging in such situations and can be life-threatening. It is beneficial for the cardiac surgical team to be aware of protocols to rewarm a patient in situations of the rare times when a replacement device is not available. The risks associated with a manual heater/cooler setup include maintaining the appropriate water bath temperature relative to patient temperature and air embolism (6,7). Heater/cooler malfunctions are a commonly reported hardware failure during CPB (2,3), so having a replacement device is important to ensure patient safety. If replacement devices are not available because of situational circumstances, such as remote areas of developing countries and stand-alone rural or newly established cardiac units in developing countries, awareness of contingency plans can be lifesaving.

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